

CONNECTANT FORMS BETWEEN THE MUSCOID AND ANTHOMYOID FLIES.

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The object of this communication is to point out certain forms which appear to be transitional between the muscoid and anthomyoid types, to call attention to their evident affinities, and to suggest characters which may be used for establishing a boundary line between these two natural groups of flies.

Girschner's system, proposed in 1893, recognizing two groups which he called *Tachiniden* and *Anthomyiden*, contains many elements of truth. It has resulted in demonstrating muscoid affinities in certain forms hitherto accepted without question as anthomyoid. Bezzi and Stein have followed this system in their catalogue, and Schnabel and Dziedzicki have recently attempted to reinforce it in their treatment of the anthomyoid flies. What concerns us chiefly in the present consideration is the fact that *Musca* and its immediate allies fall in the *Anthomyiden* according to this system. The concept is fundamentally wrong nomenclatorially, however it may be justified otherwise. Whatever group *Musca* is found to fall in must take its name from that genus. If Girschner's group *Anthomyiden* be adhered to as it stands, its name must be *Musciden* according to all accepted rules of nomenclature. But it is certain that many characters remain to be investigated before this grouping can safely be pronounced a natural one, for the main separation is founded practically on a single character—the presence or absence of hypopleural bristles.

The solution of the question practically hinges on whether *Musca* is, or is not, more closely allied to *Anthomyia* than it is to *Calliphora*. Wherever *Musca* goes, it will carry with it a considerable contingent—*Stomoxys*, *Muscina*, *Mesembrina*,

Glossina, all their immediate allies, and quite probably a block of forms hitherto classed as Anthomyiidae. The position of *Calliphora* has never been questioned, but the other forms are more or less connectant between *Calliphora* and *Anthomyia*, and the affinities of *Musca* have long been confused with those of the truly connectant forms. We are thus practically in the rather paradoxical position of being unable to place taxonomically the type of the superfamily Muscoidea, which seems inclined to fall in the Anthomyioidea.

If *Musca* prove to be more nearly related to *Anthomyia* than to *Calliphora*, then one of two things must result. Either the Muscoidea in the writer's sense must extend itself to include all the anthomyioid flies; or the latter must be grouped with *Musca* and the connectant forms into a totally different superfamily to be known as the Muscoidea, thus completely changing the sense of the name and leaving the Calliphorinae and higher groups to form a superfamily by themselves. It is therefore evident that a pressing necessity exists for fixing definitely the status of *Musca* with relation to the connectant forms that intervene between *Anthomyia* and *Calliphora*.

Certain students, not caring to proceed farther, will adopt the former solution of the difficulty and thus dismiss the whole subject. But this is not the correct solution, for it obscures the real affinities of the two groups. The anthomyioid flies, as a whole, present a far greater contrast with the rest of the Schizometopa, which is to say Muscoidea, than do the various groups of the latter with each other. Moreover, there are at least two family types—*Coenosia* and *Anthomyia*—represented in the Anthomyioidea, and it is a question whether *Drymeia* does not constitute a third and *Fannia* a fourth. Nor can we reduce the value of the taxonomic groups one notch, thereby considering the whole Schizometopa as one superfamily, for such action would only compel the inauguration of a new category farther down the line in order to preserve a proper conception of relationships. The anthomyioid flies constitute a superfamily of the atypic class, which is to say that they occupy a position entirely outside the proper limits of the superfamilies Muscoidea and Borboroidea (Holometopa excl. Conopidae), but intermediate between the two. As such they claim separate recognition.

In order to fix permanently the taxonomic status of *Musca*, a comparative study must be made of *Anthomyia pluvialis* L., *Calliphora erythrocephala* Mg., *Musca domestica* L., the connectant forms and the main anthomyioid types, along the following lines:

- (1) Chaetotaxy.
- (2) Pilotaxy—This term is coined to designate the disposition of hairs and pile in the Diptera in general and the Muscoidea in particular.
- (3) Pleural and other external thoracic anatomic characters.
- (4) Venation.
- (5) Male reproductive system.
- (6) Female reproductive system.
- (7) Hypopygium.
- (8) Egg.
- (9) First-stage maggot.

Lowne has worked out *Calliphora erythrocephala* quite extensively, and Hewitt has done the same for *Musca domestica*. *Anthomyia pluvialis* needs similar attention before exact comparisons can be instituted. As to male reproductive-system characters in the connectant and anthomyioid forms, *Stomoxys* has been worked out by Roubaud, and verified by others including the writer. *Othellia*, *Haematobia*, *Hypodermodes* and *Morellia* have been worked out by Thompson, the last two not yet published; *Muscina*, *Synthesiomyia*, *Morellia*, *Limnophora*, *Leucomelina*, *Fannia* and Gen. Indet. have been worked out by the writer. In addition to these many nonconnectant muscoid forms have been investigated as to the male reproductive system by both Thompson and the writer, and *Auchmeromyia* and *Choeromyia* have been similarly worked out by Roubaud. All of the above named connectant and anthomyioid genera except *Fannia* agree with *Musca* in lacking the male accessory glands. *Fannia* and all the nonconnectant muscoid forms possess such glands, though they may be rudimentary in the higher forms.

The writer has worked out the female reproductive system and egg in *Stomoxys*, *Muscina*, *Synthesiomyia*, *Leucomelina*, *Limnophora* and *Spilogaster*, besides many nonconnectant muscoid genera. The first three agree with *Musca* and the Calliphorinae in egg characters, but the last three differ considerably from them in these characters. Available data on the lines above specified are presented below.

CHAETOTAXY AND PILOTAXY.

Higher Muscoidea	{ Hypopleural bristles present in a more or less vertical row, pteropleural bristles present; when 3 sternopleural bristles present, their formula is either 2.0.1 or 1. 1. 1—All muscoid families except Muscidae, Oestridae, Cuterebridae. True hypopleural bristles present, pteropleural bristles absent but in their place hairs or pile; sternopleural bristles 2. 0. 1 or 1.0.1—Bengaliinae (Calliphorinae). Macrochaetae entirely absent; row of hypopleural hairs present homologous with true hypopleural bristles—Gastrophilus and Cobboldia.
Typical Muscoidea.	{ True hypopleural bristles absent, hypopleural hairs and pile absent; pteropleural bristles present, also often pteropleural hairs or pile; sternopleural bristles 1. 0. 2— <i>Musca</i> , <i>Morellia</i> and <i>Glossina</i> .
Connectant Muscoidea	{ Hypopleural hairs present, pteropleural hairs absent; sternopleurals 1. 0. 2 or 0.0.2— <i>Synthesiomyia</i> and <i>Graphomyia</i> . Hypopleural hairs and bristles both absent; pteropleural hairs, sometimes of a bristly nature, present; sternopleurals none, 0.0.1, 1.0.1, or 1.0.2-4— <i>Haematobia</i> , <i>Hypodermodes</i> , <i>Mesembrina</i> , <i>Eumesembrina</i> , <i>Pyrellia</i> , <i>Orthellia</i> . Hypopleural and pteropleural hairs present; sternopleurals 0.0.1— <i>Stomoxys</i> . Neither hypopleural nor pteropleural hairs, pile or bristles present; sternopleurals normally only 3 and formula 1.0.2 (abnormally 2.0.2)— <i>Muscina</i> , <i>Myospila</i> , <i>Clinopera</i> , <i>Leucomelina</i> , Gen. Indet., <i>Limnophora</i> , <i>Aricia</i> , <i>Spilegaster</i> .
Anthomyioidea	{ Neither hypopleural nor pteropleural hairs; sternopleurals 3 or more and rarely 1.0.2— <i>Anthomyia</i> , <i>Fannia</i> , <i>Coenosia</i> .

PLEURAL ANATOMY

The name *squamopleura* is hereby proposed for the inferior swollen lobe of the metapleura of authors, being the lower lobe of the lateral plate of postscutellum (Hewitt). The sclerite in question is a part of the mesothorax. The term metapleura is thus misapplied here, since metapleura can have no place in mesothoracic terminology. The metathorax is represented in the Muscoidea by the metasternum, whose lateral wings are termed the hypopleurae; and by the true metapleura which is situated behind the hypopleura, the metanotum being practically evanescent.

The squamopleura exhibits characters in connection with the hypopleura and the posterior thoracic spiracle which are at times of importance. It therefore requires a special designation though it is not apparently a separate sclerite. It is sometimes bare, often pilose or hairy, sometimes bristly, while the position of the spiracle with reference to it and the hypopleura may be used in the separation of groups among the connectant forms.

Higher and Typical Muscoidea	{ Posterior thoracic spiracle behind vertical axis of squamopleura and hypopleura— <i>Musca</i> , bulk of Muscoidea, <i>Leucomelina</i> , <i>Limnophora</i> , <i>Spilogaster</i> , Gen. Indet., <i>Fannia</i> .
Anthomyioidea Connectant Muscoidea	{ Posterior thoracic spiracle squarely interposed between the squamopleura and hypopleura— <i>Muscina</i> , <i>Synthesiomyia</i> , <i>Morellia</i> , <i>Aricia</i> (last judged from figures).

VENATION

Higher and Typical Muscoidea	{ Fourth vein when complete or apical crossvein when present reaching margin at or before extreme wingtip, the hind cross-vein always joining fourth vein well before bend of latter or origin of apical crossvein— <i>Musca</i> , bulk of Muscoidea, but including only <i>Cobboldia</i> among the Oestridæ and allies.
	{ Fourth vein always complete and reaching margin before wingtip, the apical cross-vein not present, the hind cross-vein practically in line with the last section of the fourth vein— <i>Glossina</i> , <i>Cuterebridæ</i> , <i>Hypodermiinae</i> , <i>Oestrinae</i> .
	{ Fourth vein incomplete, not reaching wing margin; apical and hind cross-veins obsolete— <i>Gastrophilus</i> .
Connectant Muscoidea	{ Fourth vein always complete, reaching margin behind extreme wingtip, always bowed forward apically; no apical crossvein— <i>Stomoxys</i> , <i>Haematobia</i> , <i>Lyperosis</i> , <i>Hypodermodes</i> , <i>Eumesembrina</i> , <i>Muscina</i> , <i>Myospila</i> , <i>Clinopera</i> , <i>Pararicia</i> , <i>Leucomelina</i> ; the last three with least forward bow to fourth vein and thus most approaching the anthomyioid type.
Anthomyioidea	{ Fourth vein not bowed forward in any part of its extent, but often bowed backward apically— <i>Limnophora</i> , <i>Spilogaster</i> , <i>Fannia</i> and other Anthomyioidea.

Of the above *Haematobia* furnishes an aberrant form of the *Stomoxys* type, and *Glossina* an aberrant form of the *Musca* type. Only *Clinopera*, *Pararicia* and *Leucomelina* are intermediate between the *Stomoxys* and *Anthomyia* types. A number of forms are intermediate between the *Stomoxys* and *Musca* types.

REPRODUCTIVE SYSTEM.

Higher Muscoidea	{ Male with accessory glands always more or less developed, at least their rudiments visible; female usually with a large number of ovarioles—All Muscoidea down to and including the Calliphorinæ.
Typical Muscoidea	{ Male without accessory glands, with very long and curled ejaculatory duct whose head is developed into a very elongate vesicula seminalis; female without uterus, with many functioning ovarioles—Musca, Muscina, Synthesiomyia.
	{ Same as preceding, but ejaculatory duct of male much shortened, not over 3 to 5 times as long as the vas deferens, with more than half of it functioning as vesicula seminalis—Morellia, Stomoxys, Haematobia*.
	{ Male without accessory glands; female with only one or two functioning ovarioles, one or two maggots or eggs developing at a time in the uterus—Glossina,* Dasyphora,* Mesembrina, Hylemyia.*
Connectant Muscoidea	{ Male without accessory glands; female with few ovarioles, depositing large eggs which hatch shortly into maggots omitting the second stage and developing rapidly—Hypodermodes, Eumusca,* Myospila.*
	{ Male without accessory glands; female with few ovarioles, depositing a small number of large eggs—Orthellia, Graphomyia,* Pyrellia.*
	{ Male without accessory glands, with very long vas deferens communis present and long vesicula seminalis; female with few ovarioles, depositing a small number of large eggs—Leucomelina, Limnophora, Spilogaster*.
	{ Male without vas deferens communis or accessory glands, with very short ejaculatory duct—Gen. Indet.
Anthomyioidea	{ Male without vas deferens communis, with accessory glands, with bulbous vesicula seminalis at head of the very short ejaculatory duct—Fannia.

The term *vas deferens communis* is here proposed for the slender tube present in some forms extending from the union of the two vasa deferentia to the beginning of the swollen and more or less elongate vesicula seminalis, and apparently not to be interpreted as a part of the ejaculatory duct. It is short in certain Borboroidea (*Paralimna* sp. for example) and Syrphoidea (*Volucella* sp.), but very long in *Leucomelina* and *Limnophora*. It seems to be the homologue of the common oviduct of the female, notwithstanding Berlese's homologies in his Gli Insetti (p. 841).

*Some doubt exists as to whether the 9 starred genera agree with the male characters given.

HYPOPYGIUM

Worked out by Schnabl and Dziedzicki for a large number of connectant as well as true anthomyioid forms. The characters agree in a general way throughout the connectant forms much as do those of the female reproductive system, not appearing to furnish variations of sufficient scope for definite separation into two main groups, except to mark off the Coenosiidæ from the other forms. But they will doubtless be of much use in the separation of small groups. The Calliphorine and higher muscoid groups need the same careful study for comparison with the excellent results of these authors on the forms which they have investigated.

EGG

Leucomelina, *Limnophora* and *Spilogaster* differ considerably in egg structure from *Musca*, *Muscina*, *Synthesiomys*, *Stomoxys*, the *Calliphorinæ* and higher groups. They deposit a small number of very large elongate eggs, either heavily striate longitudinally or ribbed, or very minutely scaled-reticulate, very slightly curved, yellowish-whitish in color, with thick chorion, translucent-enameled in appearance.

It is probable that these approximate the characters of the eggs of *Orthellia*, *Graphomyia*, *Pyrellia*, *Myospila*, *Eumusca* and *Hypodermodes*, all of which deposit only a small number of very large eggs.

The egg may be expected to furnish important characters for the separation of the connectant forms.

MAGGOT

The position of the anterior spiracle in the third-stage maggot of *Fannia* is quite in contrast to its position in *Musca*, being situated well forward on the third segment. Whether this holds good for *Anthomyia* and *Coenosia* is doubtful. The first-stage maggot characters, especially the cephalopharyngeal skeleton and anal stigmata, should differentiate the connectant forms from the true anthomyioids.

It appears from the foregoing that the most serviceable characters for defining the natural boundary between *Musca* and *Anthomyia* will be found in the egg, first-stage maggot, male reproductive system, chaetotaxy and pilotaxy; while the venation, thoracic sclerites, female reproductive system and hypopygium will furnish supplementary characters of value.

The indications from the very incomplete data which it has been possible to present are that *Musca* is much more nearly related to *Calliphora* than to *Anthomyia*, but final judgment must be reserved until all the main types concerned can be investigated and the results compared and correlated. The present meager notes will form a starting point for an extended study of the subject.